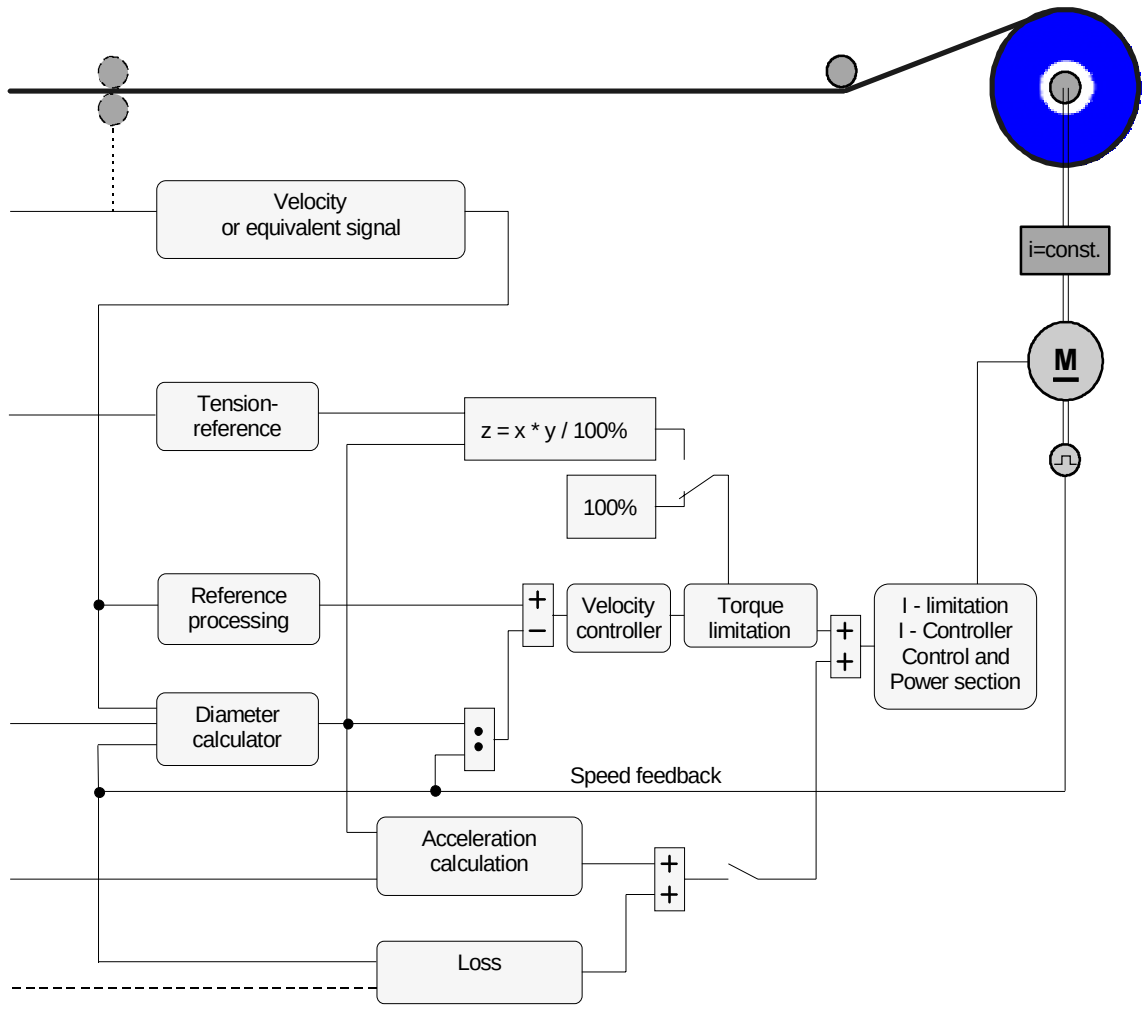
DCS 500 Software Application

Features Winder V1

3ADT069005R0101 Rev A



Application : Winder with indirect tension control

Associated application software : WINDER_1 3ADT40208xR01

Created with	:	GAD, Version 2.43/3,	Library DCS500_1.30.
Possible use	:	DCS500	S21.121 and higher
Tools required	:	DDC- oder CMT-Tool	

Important notes : Please read the notes provided on page 2

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Important notes

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Available chapters :

Features

Connection Instructions

Terminal Assignments

Software Structure Diagrams

Software Description

1. Application:

This software has been designed for winder drives intended for indirect tension control. The coil is driven via the coil shaft (centre winder).

2. Features:

- Velocity control for draw-in and jog modes, and for rapid stop
- Diameter calculator (value can be set through an external analog signal
  Calculation of the diameter from the material velocity, the motor speed and the diameter ratio.
- Selectable rewind or unwind function
  Binary switchover option in the event of external controller block
- Selectable direction of winding
  Binary switchover option in the event of external controller block
- Specification of internal references for jog mode
- Indirect tension control can be switched on and off
  Binary switchover from velocity control to indirect tension control and back again.
- Calculation of the acceleration torque from the changes in the velocity reference (dv/dt).
- Entry of current values for compensating friction losses (Iv = f(n)).
  5 value pairs (current and speed) can be stored in memory.
- Automatic switchover to the velocity control when EMERGENCY STOP is specified.
  The line is decelerated along a settable velocity ramp, without controlling the tension.

3. Technical Hints

- **Components**
  - DCS502-...
  - Field supply
  - Accessories (choke, fuses ...)
  - Option SDCS-IOE-1
- **Mechanical hints**
  - Centre winder
  - Rigid gear unit or shaft
- **Functions hints**

Velocity controlled	The actual velocity is only correctly controlled when the DCS500 has or get the actual diameter.
Indirect tension controlled	The diameter can be calculated correctly, when the wep is without any loop to the next speed controlled drive.
Range of tension	≤ 1:10
Range of diameter	≤ 1:10
Range of width	≤ 1:2
Maximum speed	≤ 500 m/min
Material	no elastic material

- **Terminal SDCS-IOB-1**

Digital inputs	Drive On Run Emergency Stop Reset Main contactor ackn. Rewinder Winder direction Winderfunction On
Analogue inputs	Tacho or encoder Speed reference Tension reference
Analogue outputs	Calculated diameter Armature voltage
Digital outputs	Main on Field on Ready running Minimal speed Signal of diameter

- **Terminal SDCS-IOE-1**

Digital inputs	Set diameter Set internal tension reference Jog 1 Jog 2
Analogue inputs	Tension reduction value

DCS 500

Connection Instructions

Software Application

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These Connection Instructions present a simple example of how the power converter can be controlled in the winder function. Standards and guidelines have not been taken into account here.

Important

The planning engineer must design the control system so as to ensure that the relevant standards and guidelines are complied with.

If motor fans and other ancillary equipment are provided, these must also be integrated.

Page 3 (Fig. Pg.3) Contactor circuitry

Page 4 (Fig. Pg.4) Connecting the DCS50x

Page 5 (Fig. Pg.5) Connection option for SDCS-IOE-1

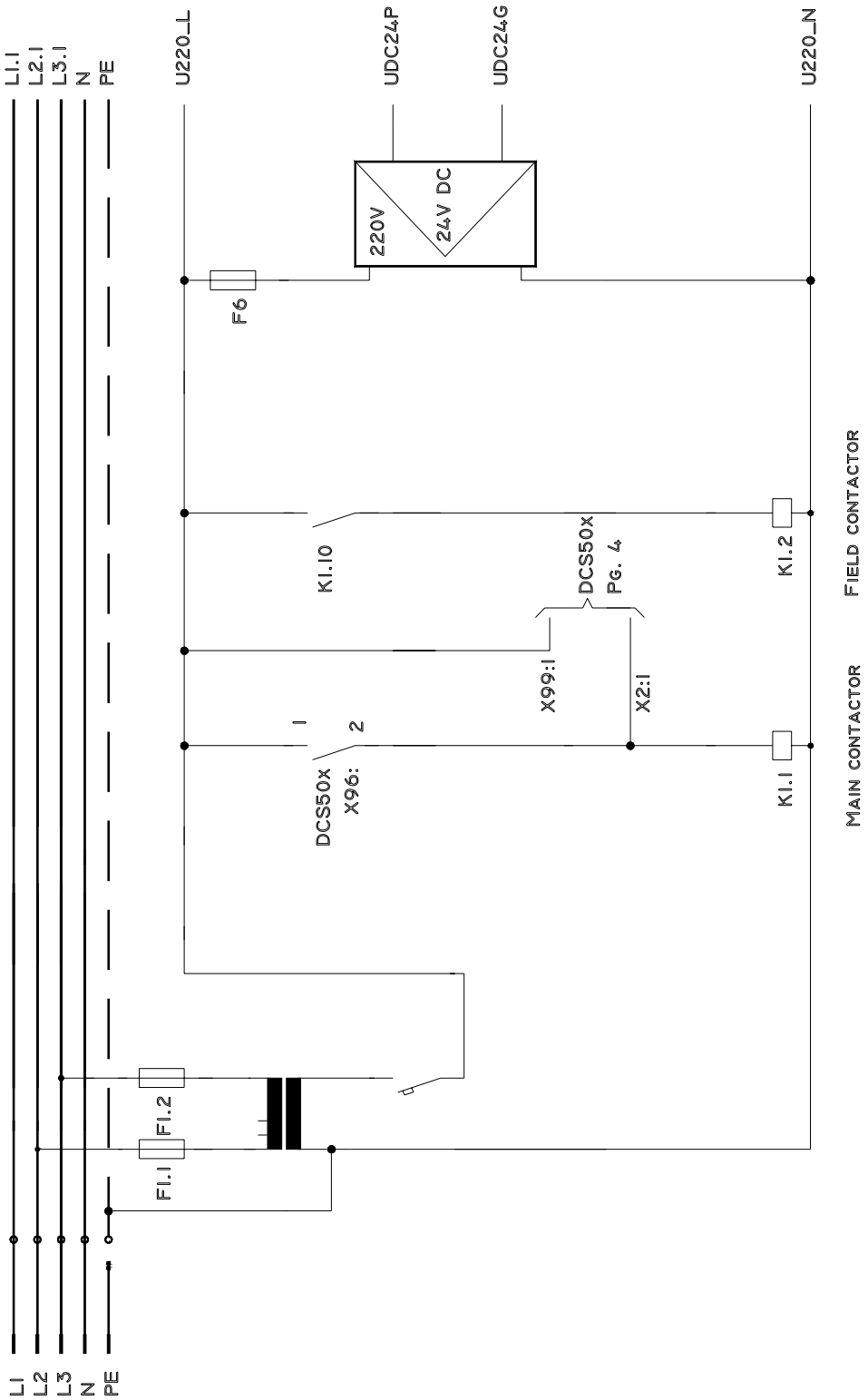
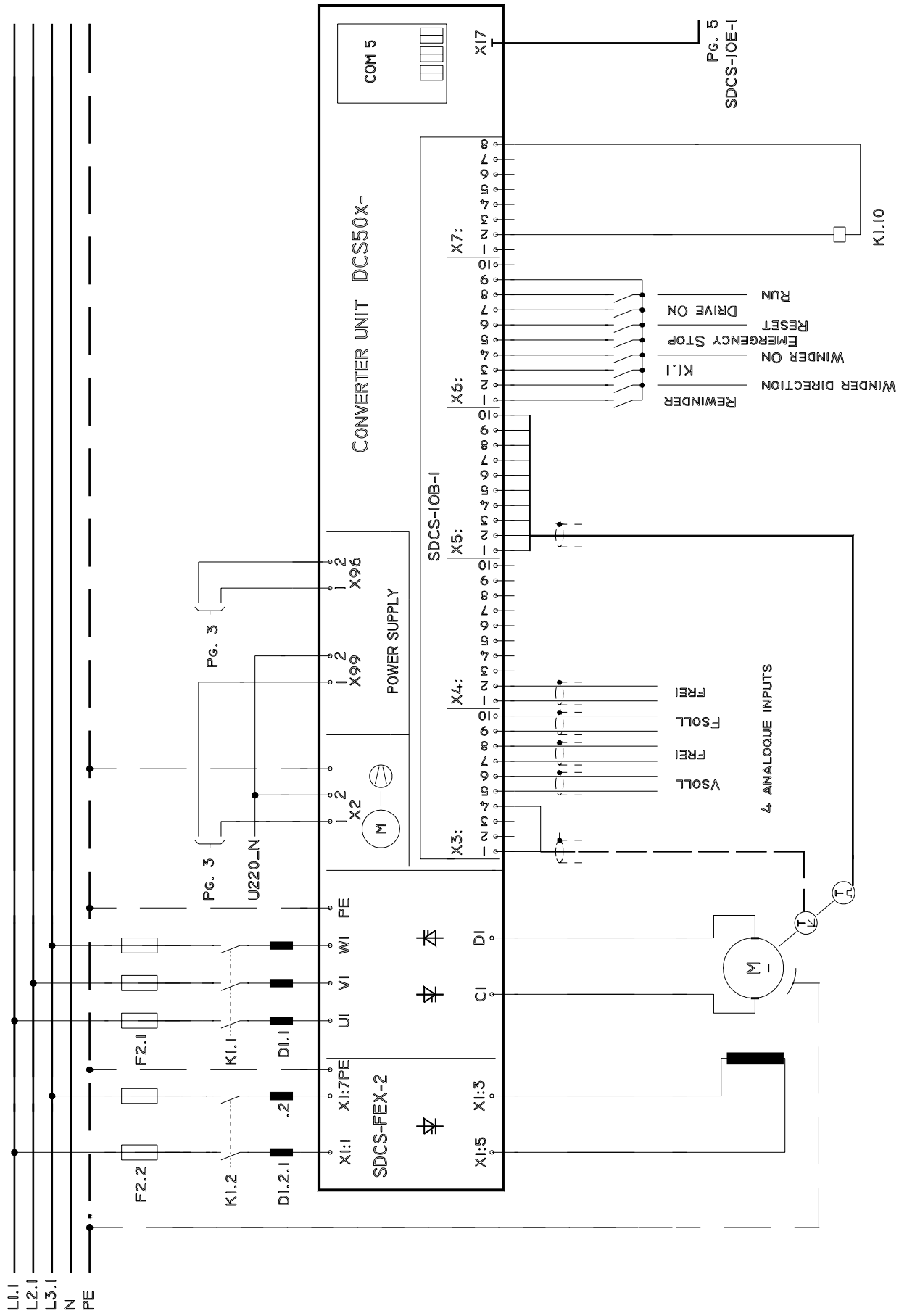

L1.1
L2.1
L3.1
N
PE
U220_L
UDC24P
UDC24G
U220_N
220V
24V DC
F6
K1.10
DCS50x
Pg. 4
K1.2
FIELD CONTACTOR
X99:1
X2:1
1
2
DCS50x
X96:
K1.1
MAIN CONTACTOR
F1.2
F1.1
L1
L2
L3
N
PE

Fig. Pg.3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L3.1
N
PE
F2.1
F2.2
K1.1
K1.2
DI.1
DI.2.1
PE
WI
VI
UI
X1:7PE
X1:1
X1:3
X1:5
DI
CI
SDCS-FEX-2
POWER SUPPLY
X96
X99
X2
PG. 3
PG. 3
U220_N
CONVERTER UNIT DCS50X-
SDCS-IOB-I
X5:
X4:
X3:
X6:
X7:
REWINDER
WINDER DIRECTION
K1.1
WINDER ON
EMERGENCY STOP
RESET
DRIVE ON
RUN
FREI
FSOLL
FREI
VSOLL
4 ANALOGUE INPUTS
K1.10
COM 5
X17
PG. 5
SDCS-IOE-I
M
M
T1
T2

Fig. Pg.4

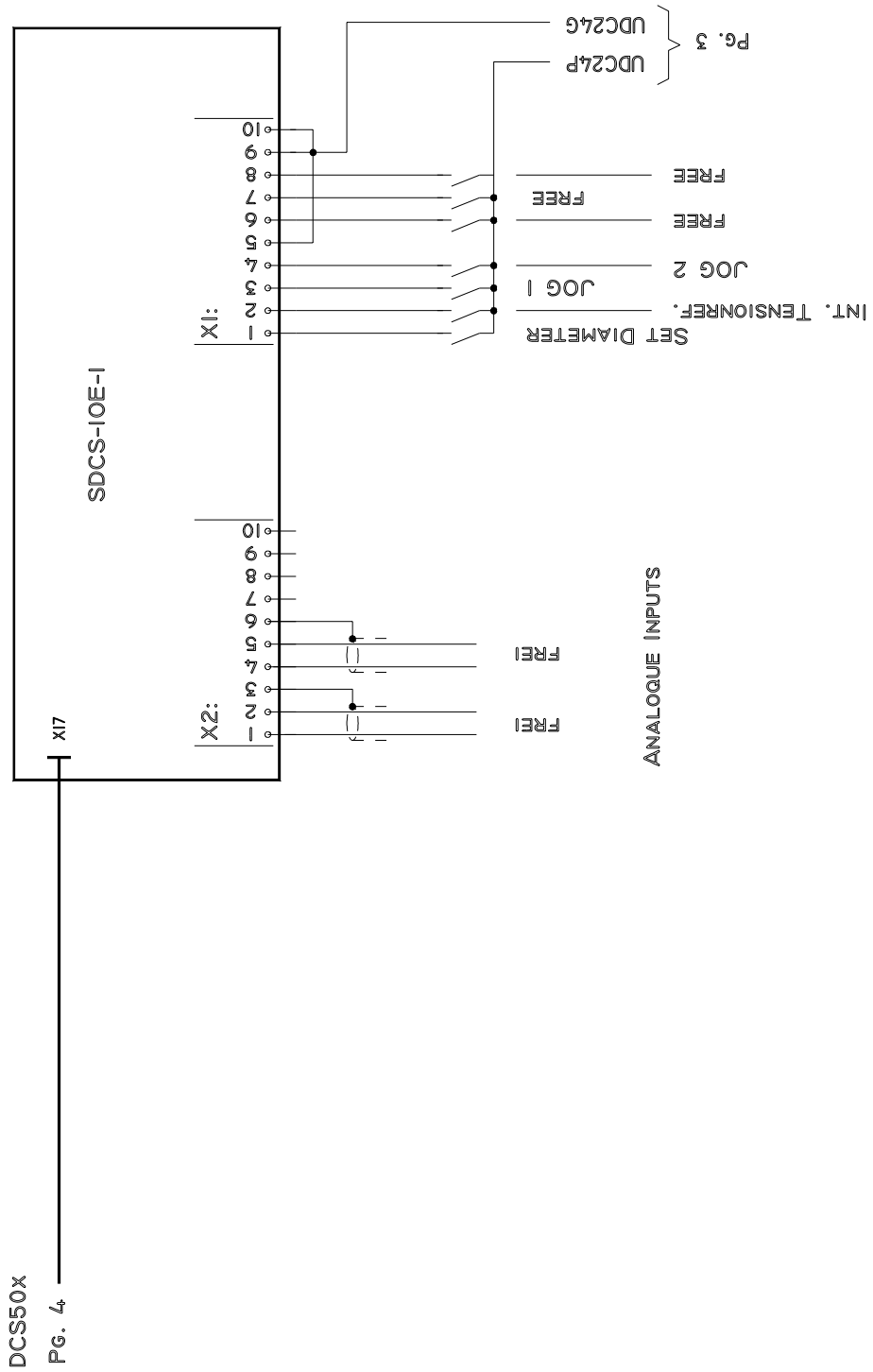
UDC24G
UDC24P
Pg. 3
10
9
8
7
6
5
4
3
2
1
X1:
SET DIAMETER
INT. TENSIONREF.
JOG 1
JOG 2
FREE
FREE
FREE
SDCS-IOE-1
10
9
8
7
6
5
4
3
2
1
X2:
FREE
FREE
ANALOGUE INPUTS
X17
DCS50x
Pg. 4

Fig. Pg.5

DCS 500

Terminal Assignments

Software Application

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Inputs (Part 1)**:**

SDCS-IOB-1 Terminal	Voltage	**SDCS-IOB-3** Terminal	Voltage	Type		Des.
X3:01	90-270V	X3:01	± 10 V	AI -		Tacho
X3:02	30-90V		(über ext.	AI -		
X3:03	0-30V		PS5311	AI -		
X3:04	0V	X3:02	... 270V)	AI +		
X3:05	± 10V	X3:03	± 10V	AI1 -		Velocity reference
X3:06		X3:04		AI1 +		
X3:07	± 10V	X3:05	± 10V	AI2 -		not assigned
X3:08		X3:06		AI2 +		
X3:09	± 10V	X3:07	± 10V	AI3 -		Tension reference
X3:10		X3:08		AI3 +		
X4:01	± 10V	X3:09	± 10V	AI4 -		not assigned
X4:02		X3:10		AI4 +		
		X3:11		to AI4		
		X3:12		to AI4		
X4:03	0V	X4:08	GND			
X4:04	+10V	X4:07	+10V			
X4:05	-10V	X4:09	-10V			
		X4:10	1.5/5mA			
		X4:11	0V			
		X4:12	Spare			

Inputs (Part 2)**:**

SDCS-IOB-1 Terminal	Voltage	**SDCS-IOB-3** Terminal	Voltage	Type		Des.
X5:01		X5:01		ChA+		Incremental encoder
X5:02		X5:02		ChA-		
X5:03		X5:03		ChB+		
X5:04		X5:04		ChB-		
X5:05		X5:05		ChZ+		
X5:06		X5:06		ChZ-		
X5:07	GND	X5:07	U (5,12,24V)			
X5:08	ENC	X5:08	U sense			
X5:09	ENC	X5:09	0V Esense			
X5:10	ENCV	X5:10	0V E			
X6:01	0..8V = 0	X6:01	depending on	DI1	Binary	Rewinder
X6:02	12..65V = 1	X6:02	jumper	DI2	inputs	Winder direction
X6:03		X6:03	24 ... 230V	DI3		Main contactor acknowledge
X6:04		X6:04		DI4		Winder On
X6:05		X6:05		DI5		Emergency Stop
X6:06		X6:06		DI6		Reset
X6:07		X6:07		DI7		Drive On
X6:08		X6:08		DI8		Run
X6:09	+48V	X7:03 / 04	+48V			
X6:10	0V	X7:02	GNDE			
		X7:01	GNDI			

Inputs (Part 3)**:**

SDCS-IOE-1 Terminal	Voltage	Type	Resolution	Des.
X1:01	24 V	DI09	binary inputs	Set diameter
X1:02		DI10		Set internal torque reference
X1:03		DI11		Jog1
X1:04		DI12		Jog 2
X1:05	0V			
X1:06	24 V	DI13		free
X1:07		DI14		free
X1:08		DI15		free
X1:09	0V			
X1:10	GND			
X2:01	± 10V	AI5-	11 bit + sign	free
X2:02		AI5+		
X2:03	Cable shield			
X2:04	± 10V	AI6-	11 bit + sign	free
X2:05		AI6+		
X2:06	Cable shield			
X2:07	1,506 / 5mA			
X2:08	0V			
X2:09	Cable shield			
X2:10	GND			

Outputs:

Des.	Resolution	Type	**SDCS-IOB-3** Voltage	Terminal	**SDCS-IOB-1** Voltage	Terminal
	11bit + sign	AO			0V	X4:06
Calculated diameter		AO1	± 10 V	X4:01 / 02	±10V (5mA)	X4:07
Actual armature voltage		AO2		X4:03 / 04	±10V (5mA)	X4:08
Actual armature current		I-act	± 10 V	X4:05	± 3V (5mA)	X4:09
				X4:06	0V	X4:10

Des.	Resolution	Type	**SDCS-IOB-2x** Voltage	Terminal	**SDCS-IOB-1** Voltage	Terminal
Min. speed	Binary outputs	DO1	Relay contact	X4: 1 / 2	24V (80mA)	X7:01
Field contactor On		DO2		X4: 3 / 4		X7:02
free		DO3		X4: 5 / 6		X7:03
Rdy. Running		DO4		X4: 7 / 8		X7:04
free		DO5		X5: 1 / 2		X7:05
free		DO6		X5: 3 / 4		X7:06
Diameter threshold		DO7	Optocoupler	X5: 5 / 6		X7:07
					0V	X7:08
					SDCS-POW-1	
					Voltage	Terminal
Main contactor on		DO8	Relay contact	X5: 7 / 8	Relay contact	X96:1/2

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Software Structure Diagrams Winder V1

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Software Structure Diagrams:

The attached structure diagrams have been created with the GAD tool, and contain all the function building blocks used for this application.

APPL	
Name	DCS500 APPLICATION WINDER
Version	21.121
Description	Velocity and tension controlling without tension feedback
Compiled	

TARGET	
Target	DCS500
Version	21.121
Library	DCS500
Version	120

SHEET	01	Contents
	02	SETUP MAIN POWER VALUES AND CONSTANTS
	03	DIGITAL INPUTS AND DRIVE LOGIC
	04	ANALOQUE INPUTS
	05	VELOCITY REFERENCE
	06	DIAMETER CALCULATION
	07	VELOCITY CONTROLLER
	08	TENSION CALCULATION
	09	ACCELERATION REFERENCE AND ACCELERATION TORQUE
	10	TORQUE AND CURRENT LIMIT AND CURRENT CONTROLLER
	11	FIELD, EMF CONTROL
	12	MONITORING (SPEED, CURRENT, MAIN LINE, WINDER) DIGITAL AND ANALOQUE OUTPUTS

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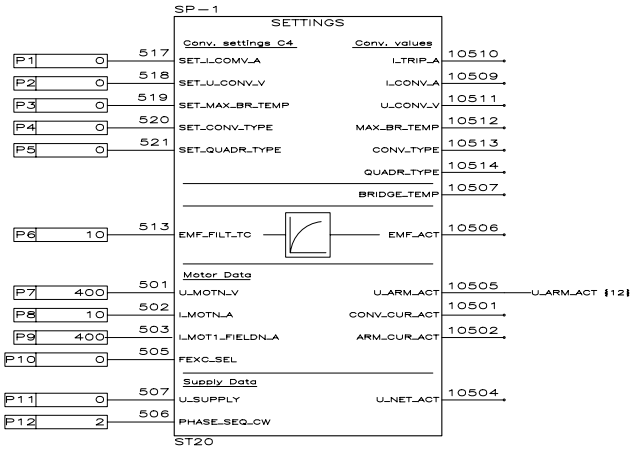

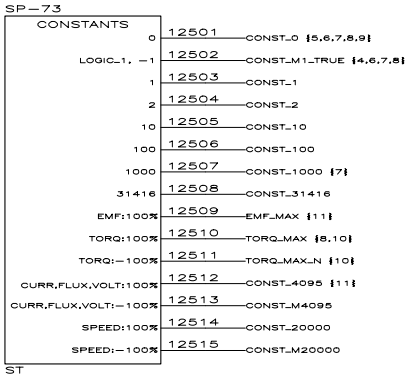

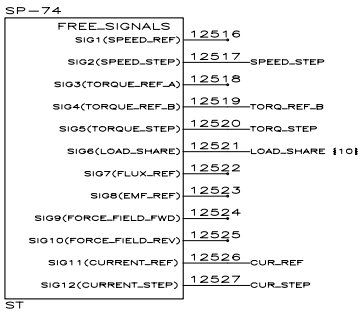

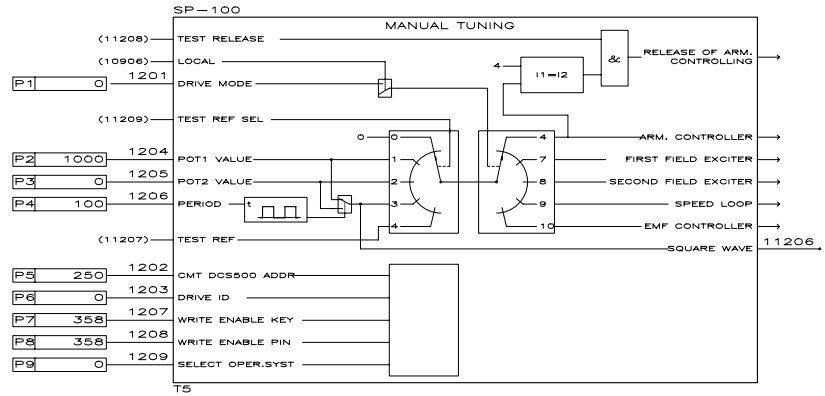

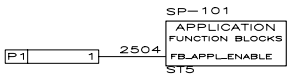

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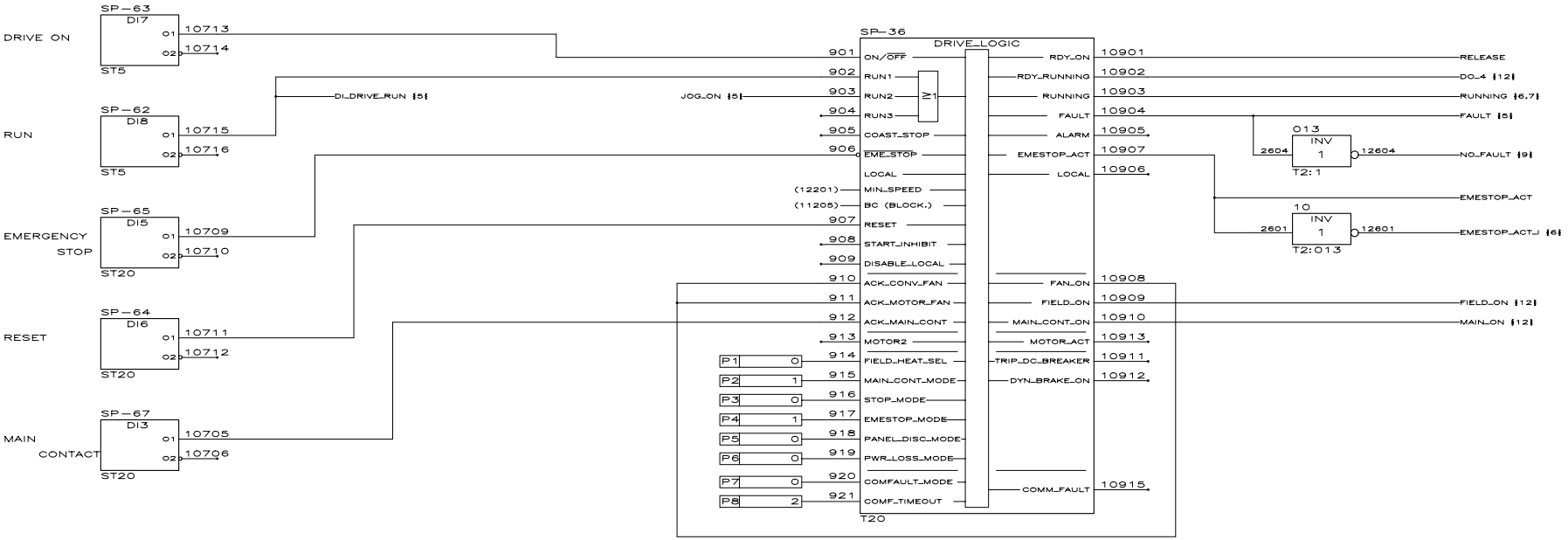

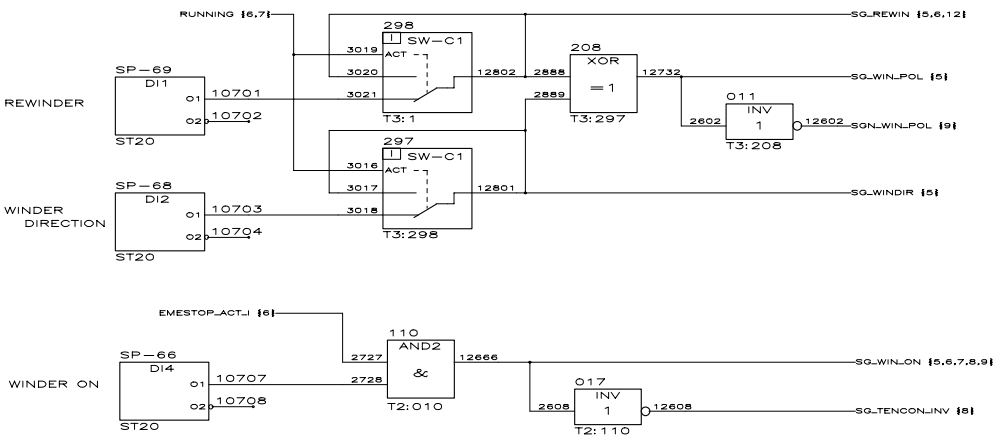

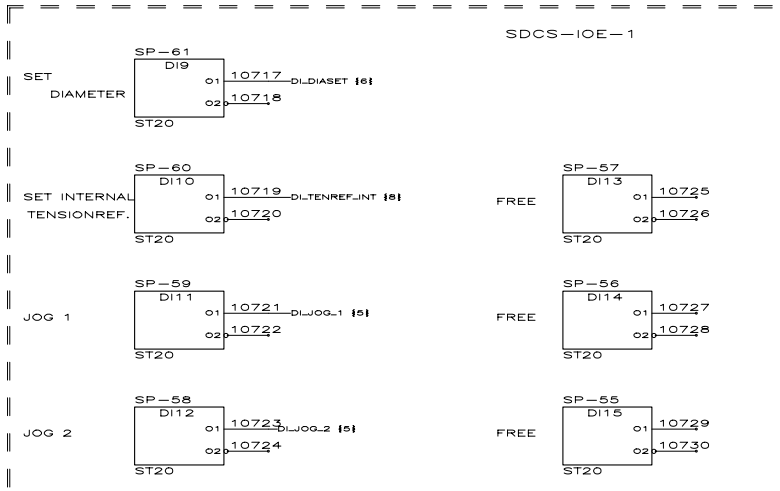

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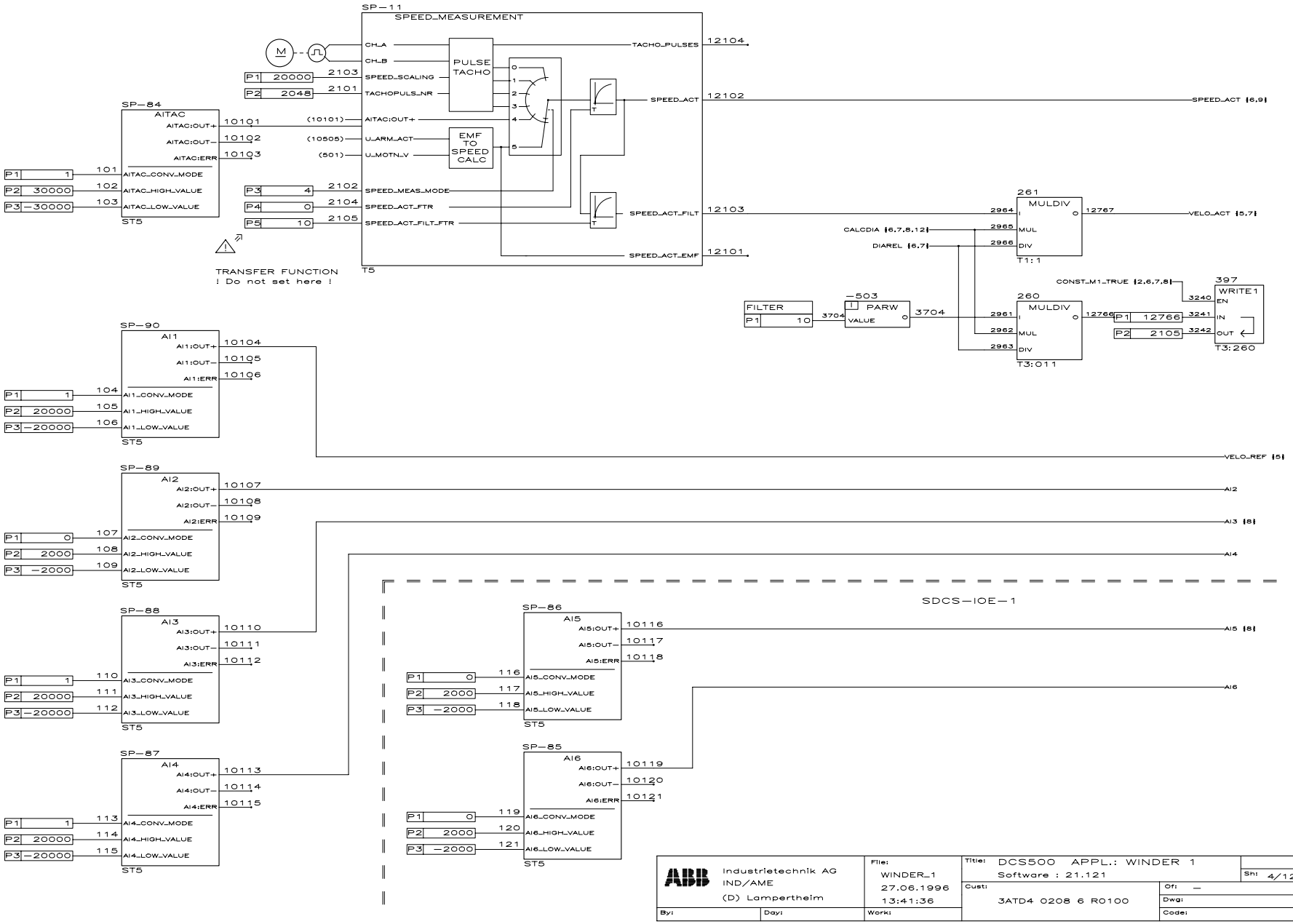

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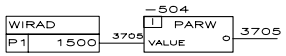
−504
WIRAD
P1 1500
3705
PARW
VALUE
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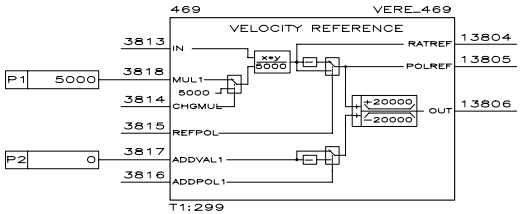
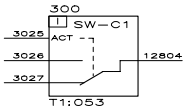

469
VERE_469
VELOCITY REFERENCE
3813 IN
RATREF 13804
x÷y
5000
POLREF 13805
P1 5000
3818 MUL1
5000
3814 CHGMUL
+20000
−20000
OUT 13806
3815 REFPOL
P2 0
3817 ADDVAL1
3816 ADDPOL1
T1:299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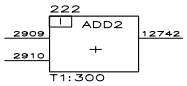
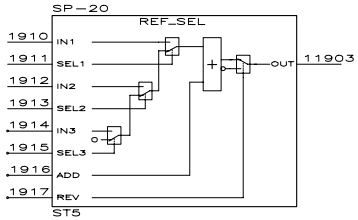
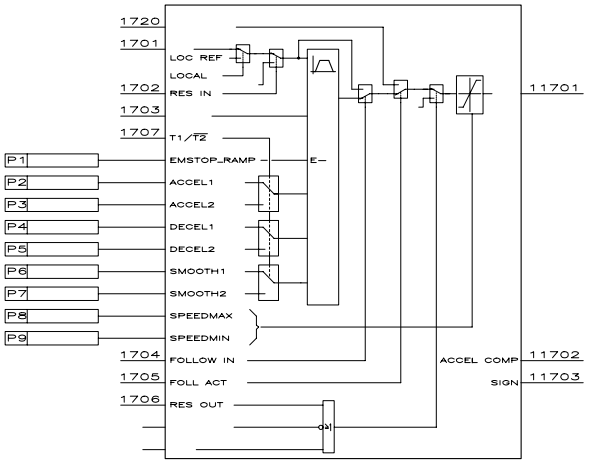
SW−C1
3025 ACT
3026
3027
12804
T1:053


222
ADD2
2909
2910
12742
T1:300


SP−20
REF_SEL
1910 IN1
1911 SEL1
1912 IN2
1913 SEL2
1914 IN3
0
1915 SEL3
1916 ADD
1917 REV
OUT 11903
ST5


1720
1701 LOC REF
LOCAL
1702 RES IN
11701
1703
1707 T1/T2
P1 EMSTOP_RAMP
E−
P2 ACCEL1
P3 ACCEL2
P4 DECEL1
P5 DECEL2
P6 SMOOTH1
P7 SMOOTH2
P8 SPEEDMAX
P9 SPEEDMIN
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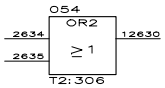
ACCEL COMP 11702
1705 FOLL ACT
SIGN 11703
1706 RES OUT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OR2
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2635
≥ 1
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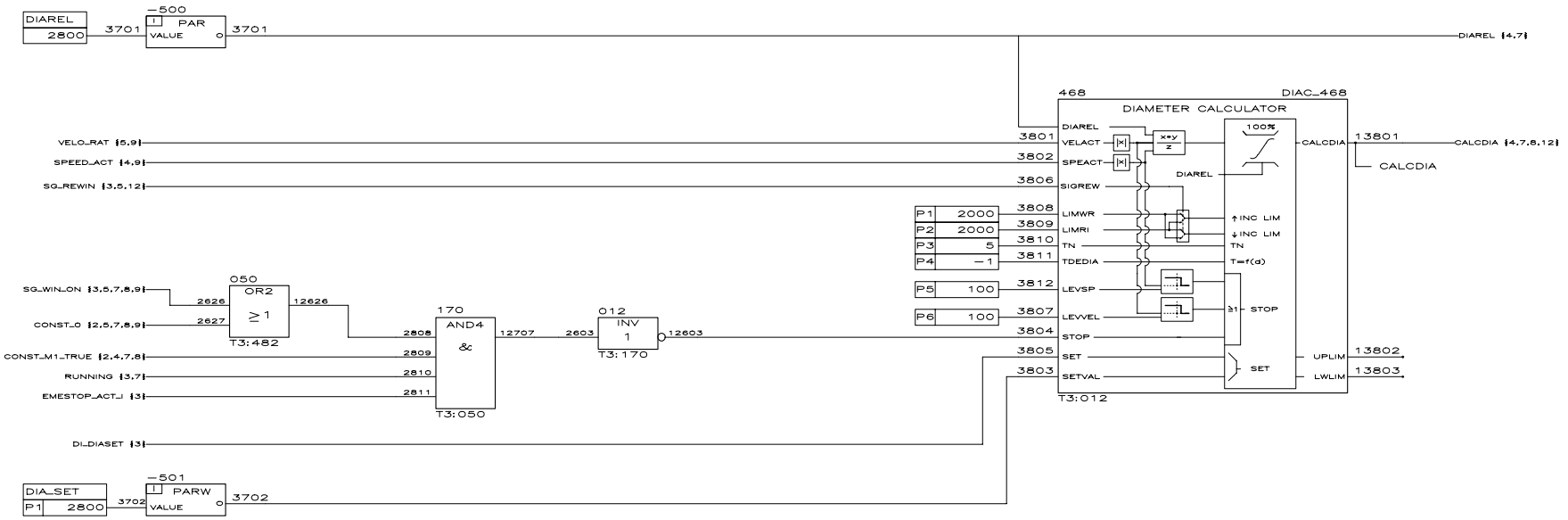

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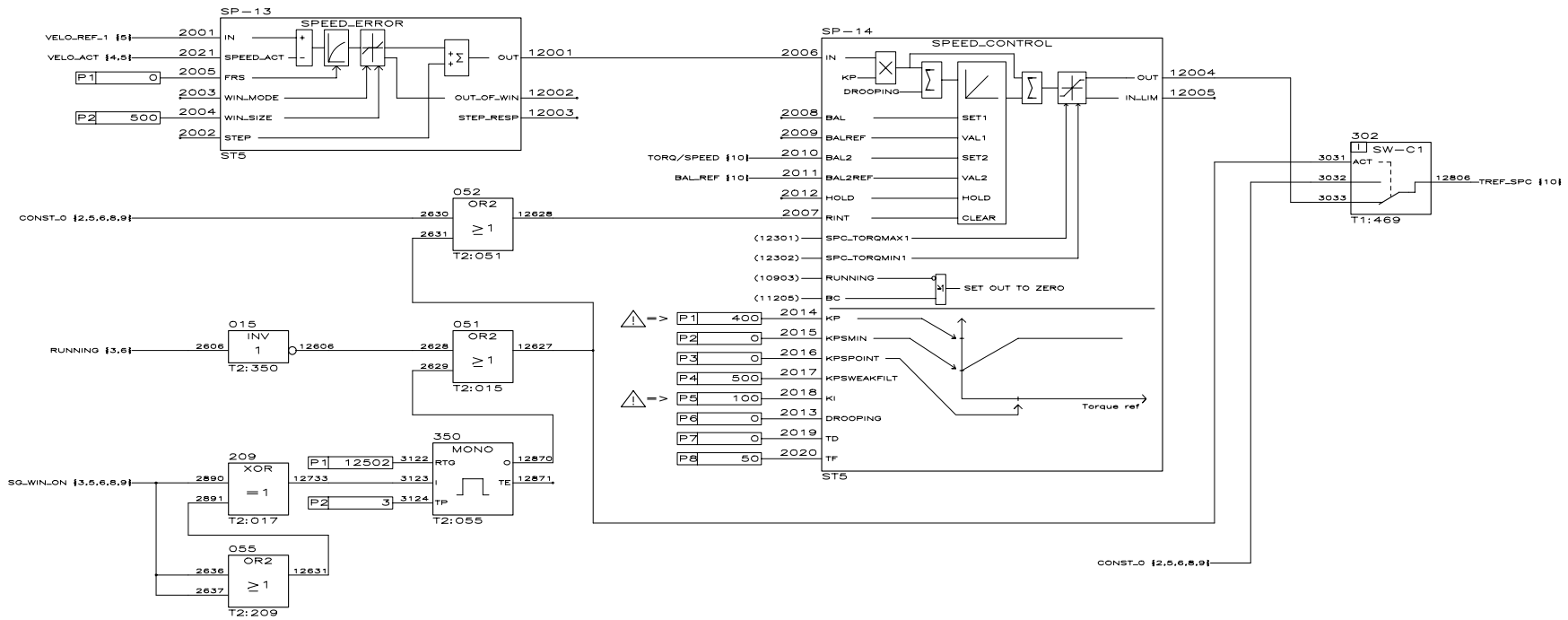

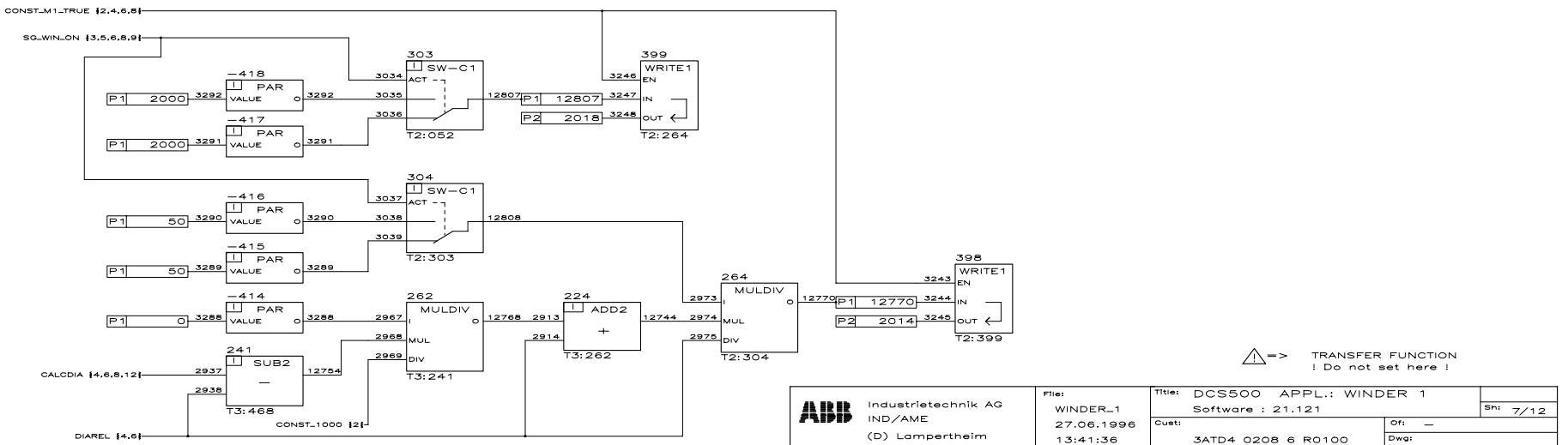

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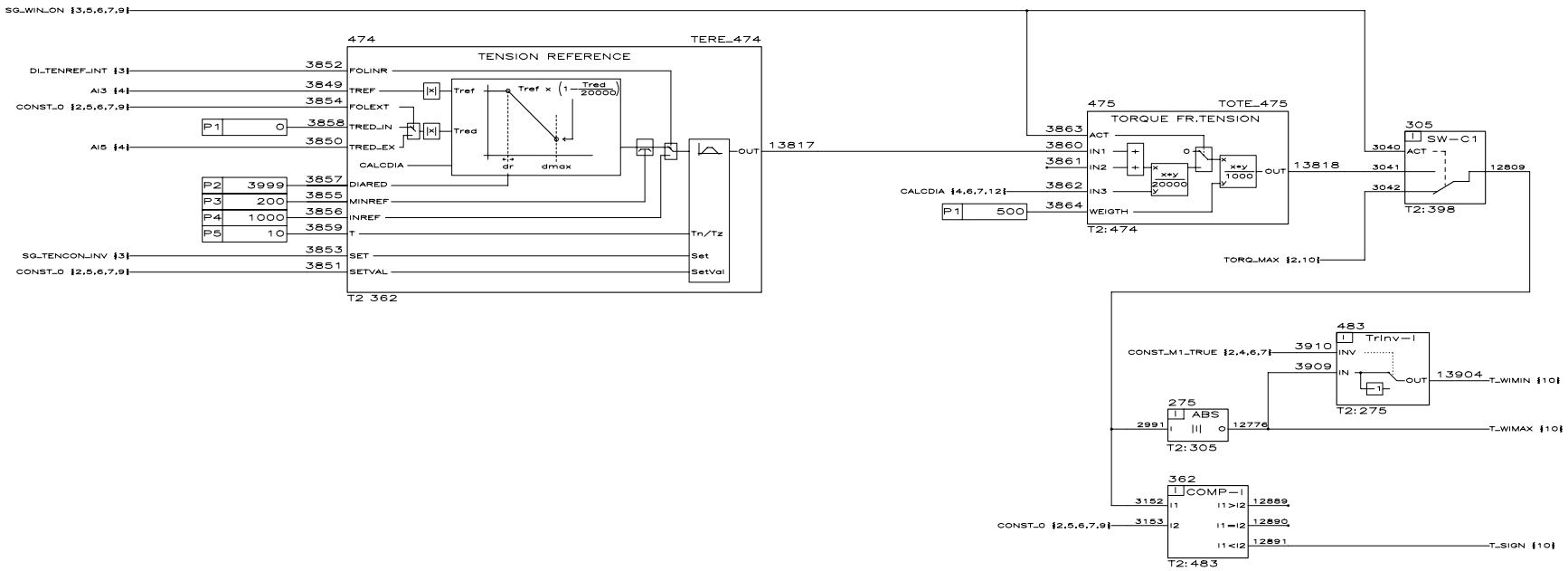
By:	Day:	Work:			



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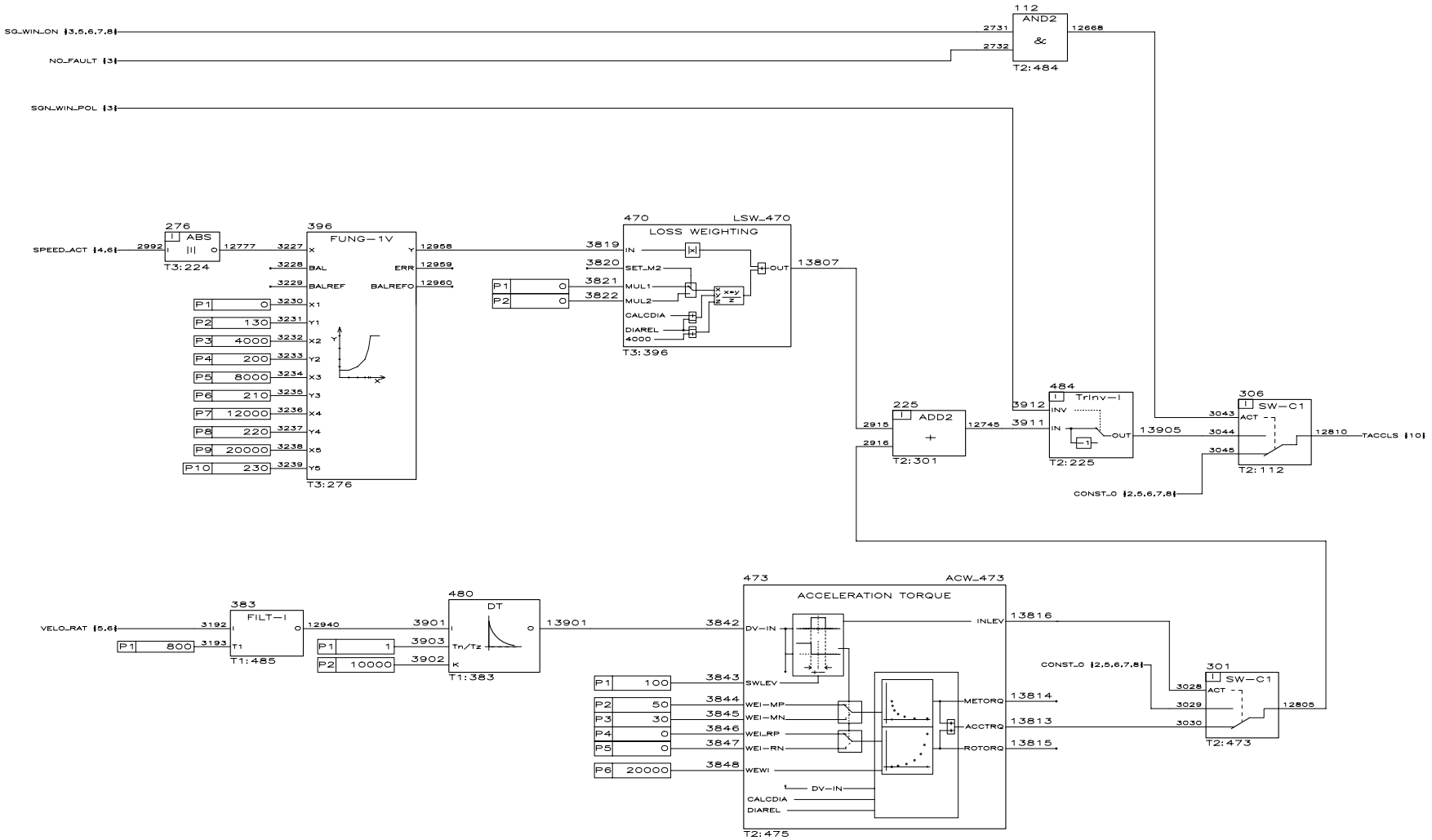

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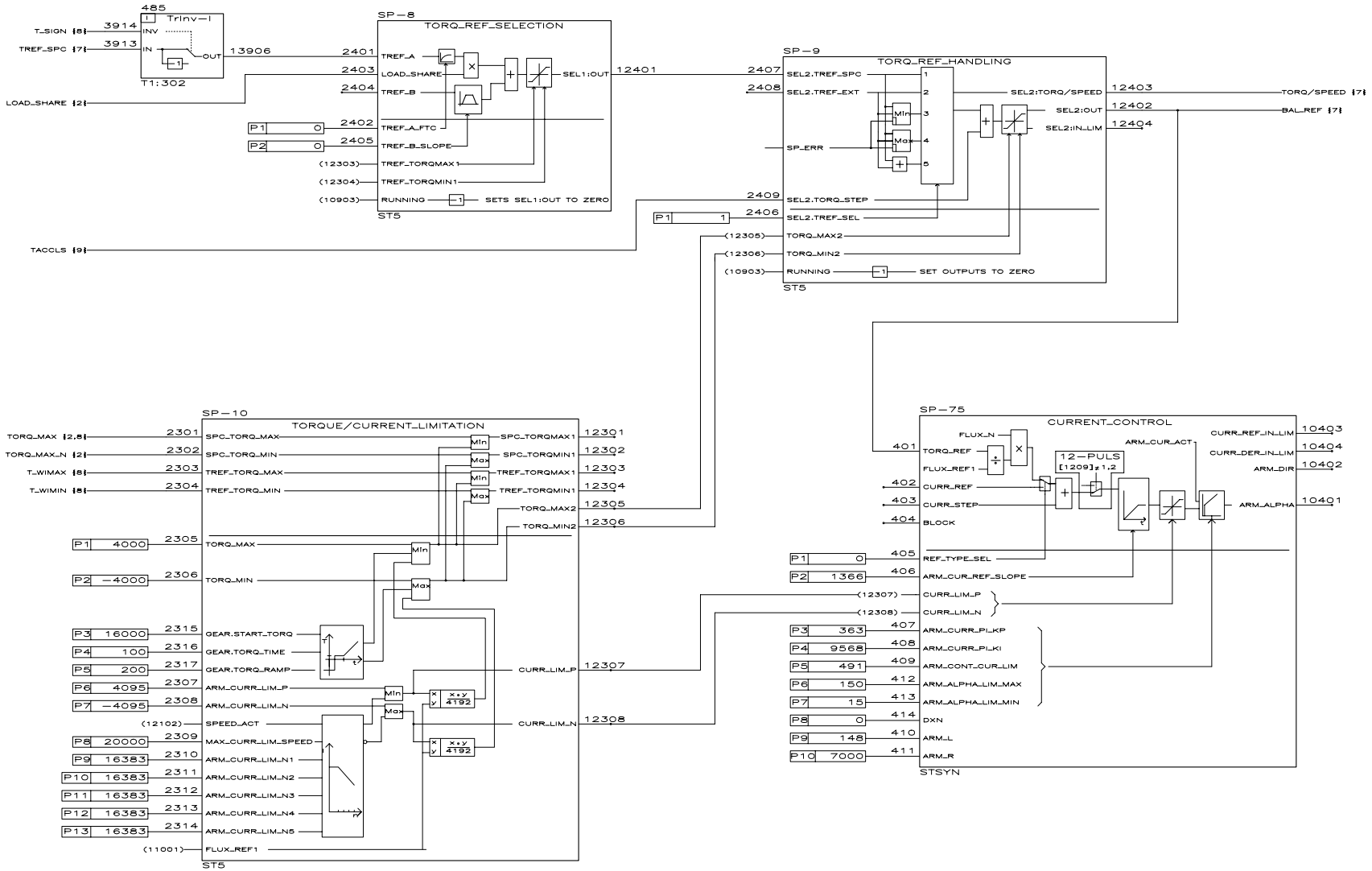
By:	Day:	Work:			



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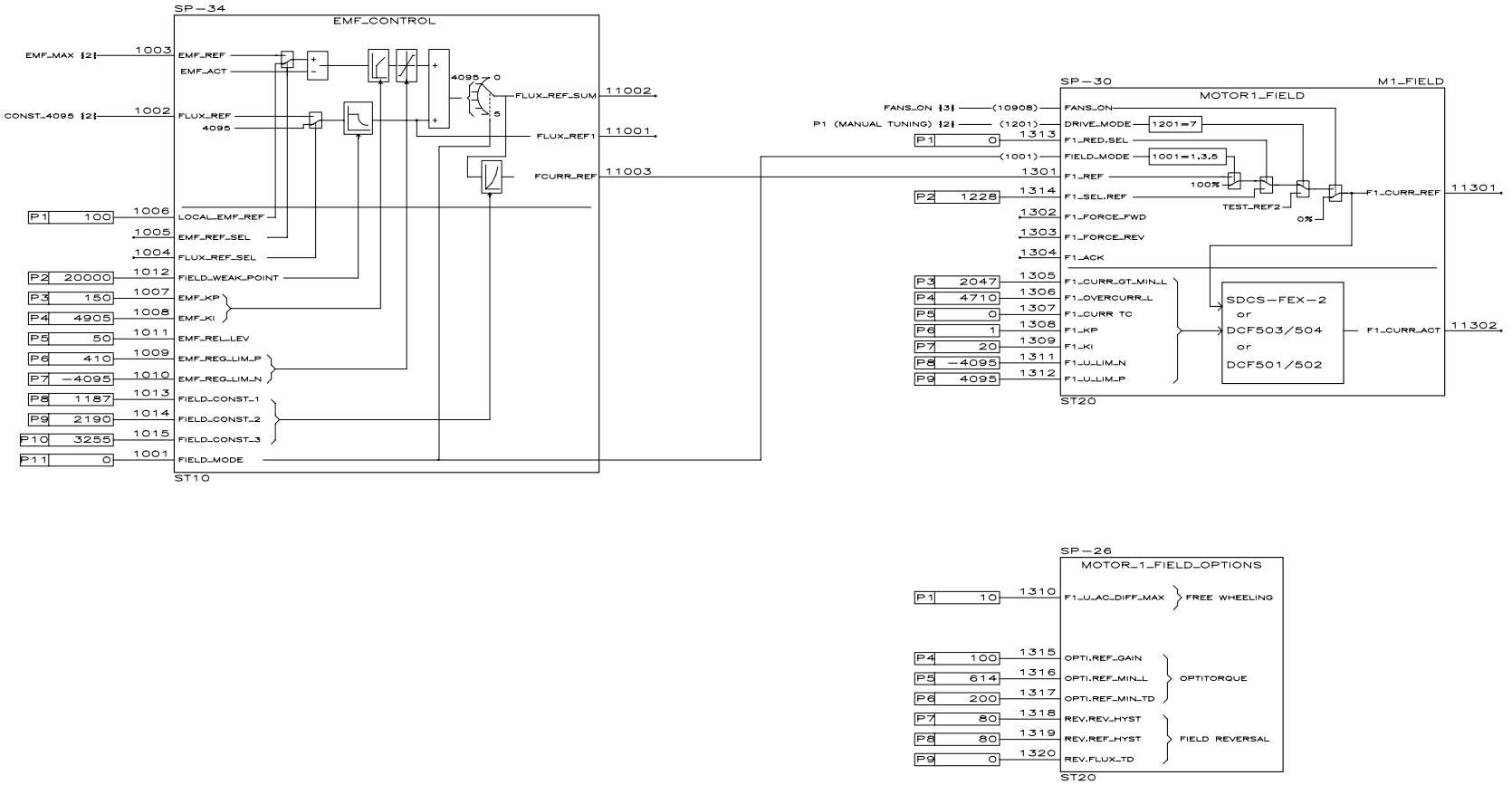

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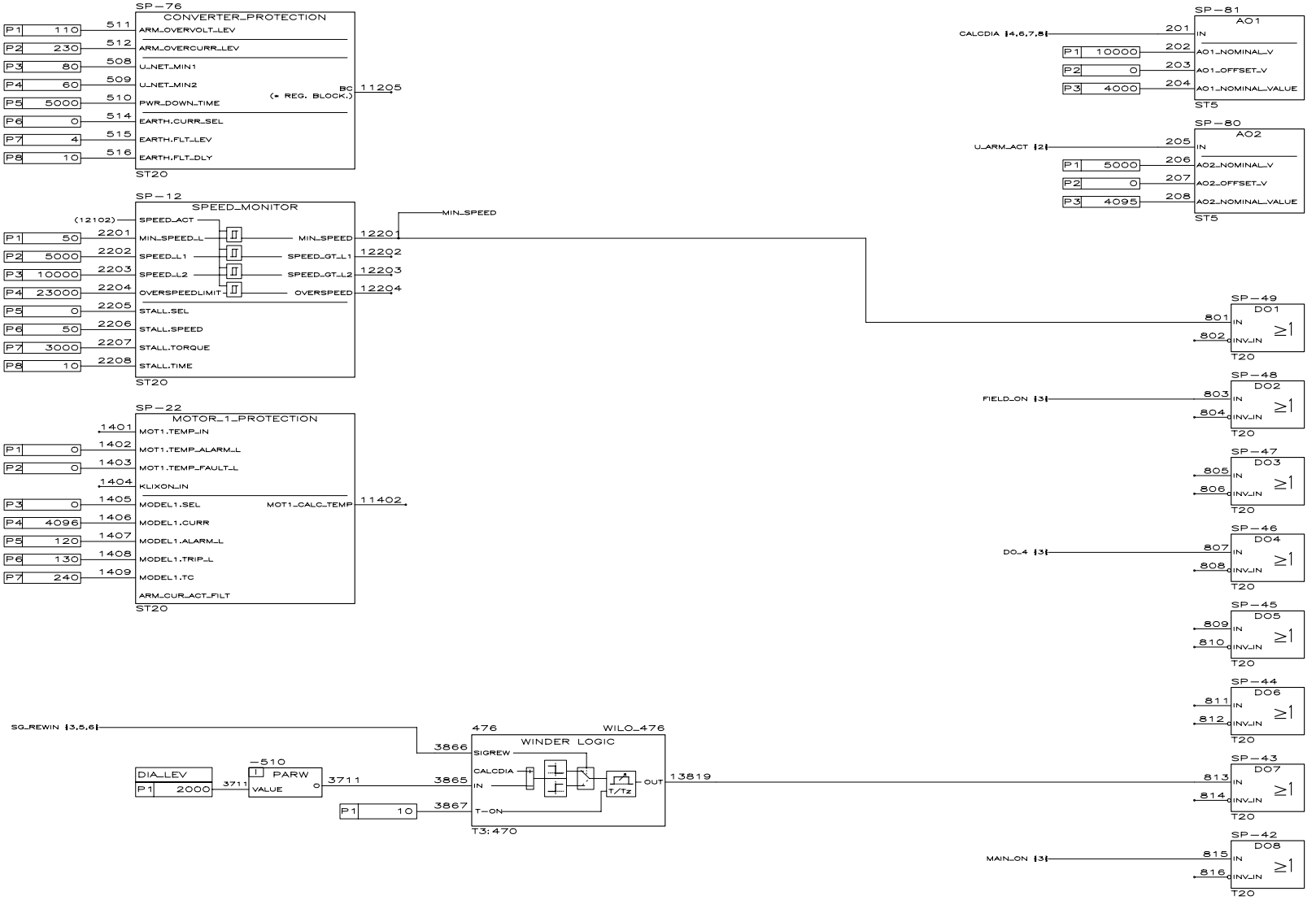
			Dwg:	
By: Day:	Work:		Code:	



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			Cust: 3ATD4 0208 6 R0100	Of: – Dwg: Code:
By:	Day:	Work:		

DCS 500

Software Application

Software Description

Winder V1

3ADT069005R0101 Rev A

ABB Industrietechnik AG IND/AM

Important notes

Safety note :

For the use of this application software, the safety notes contained in the documentation for the DCS500 units (System Description, Technical Data, Operating Instructions) apply in their entirety.

This application software may be used by properly trained personnel only. Users have to be sufficiently familiar with the requisite tools and the system conditions involved to enable then to assess the suitability of this software for the actual application concerned.

This application software is a non-binding example, which will not meet all system conditions in every individual case. We accept no responsibility for the use of this software.

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1. General conditions

This application has been planned for a winder drive with an indirect tension control.

- Velocity control with an external reference. This necessitates specification of the correct diameter.

- Tension mode with an external tension reference. Note that the diameter can be computed internally if the velocity reference corresponds to the actual material velocity,.

Note:

The terminals listed in this description are referenced to the Board SDCS-IOB-1 (installed in the DCS unit).

P. : **indicates the relevant page in the Software Structure Diagram.**

An operational power converter includes the power supplies and the RUNNING, EMERGENCY-STOP (inverted) and DRIVE-ON commands at the appropriate terminals.

Parameter : P. 2/12

	FB :	SETTINGS	
501	P7	U MOTN V	Rated motor voltage
502	P8	I MOTN A	Rated motor current
503	P9	I MOT1 FIELDN A	Rated motor field current
505	P10	FEXC SEL	Selection of field supply unit
506	P12	PHASE SEQ CW	Phase sequence R-S-T or R-T-S
507	P11	U SUPPLY	Supply voltage

Note on Parameter 506 :

Parameter 506 must be set at the DCS power section in accordance with the phase sequence involved. An incorrect setting for this parameter will not result in destruction, but may trigger an error message.

Command	**Terminal**	**active**	**Description**
DRIVE ON	X6:7	= 1	When the signal changes from 0 to 1, the field contactor (over X7:2) and the main contactor (Relay Contact X96:1,2) are switched on. After synchronization with the power section, the RDY RUNNING (X7:4) output is set to 1. The O-signal causes the drive to be blocked, and the outputs set above to be switched off. If the drive has been switched off by the emergency stop command or by a fault, then another signal change from 0 to 1 is required.
EME-STOP (Emergency Stop)	X6:5	= 0	When Signal = 1, no emergency stop is specified. When there is a 1->0 change, the "velocity control" operating mode is automatically selected, even if tension control mode was previously active. The drive is given zero as its reference. When the speed is approx. 0, the main and field contactors will be switched off, and message A102 will appear. After the emergency stop signal has been set to 1 again, the message must be acknowledged with RESET.
RUN	X6:8	= 1	Signal = 1 means the drive is enabled and the controllers activated. If the signal is set to 0, then under **velocity control** the drive is run down to zero over the ramp. This does **not** happen under **tension control**. In both operating modes, the controllers are blocked when the speed has dropped to approx. 0.
REWIN	X6:1		Winder type 0 => Unwinder 1 => Rewinder Switchover can be executed only if the internal RUNNING signal (enable) is not present.
WINDIR	X6:2		The "Winding Direction" command causes the sense of rotation to changes. This switchover function can be executed only if the internal RUNNING signal (enable) is not present.
RESET	X6:6		The reset command causes the fault (Fxx) and alarm (Axx) messages to be reset. Reset is executed only in response to a **signal change from 0 to 1**

1.1 Switch-on/switch-off logic

The DRIVE-ON command is used to cut in the line contactors over the outputs provided no faults or emergency stops are ongoing. The field current is built up, and the power contactor synchronized with the power voltage, which is monitored from now on.

When the DRIVE-ON command is removed, the drive is immediately blocked, and the signal outputs for the power contactors set to zero.

1.2 Voltage and current scaling

If the actual line voltage deviates from the unit's rated voltage, then the new value must be written in Parameter 507. The actual line voltage must not of course be greater than the unit's rated voltage.

The motor data must be entered in the appropriate parameters, as follows

- Rated motor voltage in Parameter 501
- Rated motor current in Parameter 502
- Rated field current in Parameter 503

The software will not detect by itself what field supply unit has been connected. So you must specify the type concerned in Parameter 505.

505 :=	0	=	NO_FIELD_EXCITER
	1	=	DIODE_FIELD_EXCT
	2	=	FEX2 OR FEX3
	3	=	FEX3 FOR MOTOR2
	4	=	FEX2/3 + MOT2=FEX3
	5	=	FIELD_ACK_VIA_DI
	6	=	FIELD_ACK_VIA_AI.

You will find more information on field control in Chapter 8.

2. Velocity control

The drive can be run under velocity control. The specified velocity can, however, be maintained only if the diameter corresponds to the actual value. This may have to be specified from outside.

In tension-controlled mode, the velocity controller serves as a velocity monitor. The velocity can, however, be maintained only if the conditions for internal diameter calculation are satisfied.

Note:
The acceleration values and the losses are directly added internally as a current value. This means that incorrect values cannot be compensated by the velocity controller, particularly in indirect tension control mode.

2.1 Velocity reference

Parameter : P. 4/12, 5/12

	FB :	AI1	Analog Input X3:5
104	P1	AI1 CONV MODE	Scaling of
105	P2	AI1 HIGH VALUE	velocity reference
106	P3	AI1 LOW VALUE	
	FB :	VELOCITY REFERENCE	Conditioning of the velocity reference
3818	P1	MUL1	Internal matching
3817	P2	ADDVAL1	Advance and lag in velocity control
	FB :	CONST_REF	Constant references
1906	P2	REF1	Jogging reference 1
1907	P3	REF2	Jogging reference 2
	FB :	RAMP	Reference ramp
1714	P1	EMESTOP RAMP	Ramp for emergency stop
1708	P2	ACCEL1	Run-up ramp
1709	P4	DECEL1	Run-down ramp
1710	P5	SMOOTH 1	Smoothing
1715	P8	SPEEDMAX	Maximum limitation (positive)
1716	P9	SPEEDMIN	Minimum limitation (negative)
	FB :	PARW_504	Parameter
3705		WIRAD	Advance and lag in tension mode

The velocity reference is specified with max. 10 V over Terminal X3:5. Since no absolute value is formed, care must be taken to ensure that the reference is always specified as positive for winder operation. The drive's sense of rotation is determined by the polarity of the motor connection (armature, field), by the "Winder Type" command (rewinder or unwinder) and by the "Winding Direction" command.

Analog input AI1 (from X3:5) can initially be calibrated to the desired value with Parameters P1, P2 and P3. A further weighting option is provided with Parameter P1 (VELOCITY REFERENCE).

The weighted reference is also utilized for calculating the diameter! Weighting and calibration of the actual value affect calculation of the diameter.

Selecting the reference and the operating mode:
All further enables are required for this purpose.

EME_STOP	DRIVE_RUN	WIN_ON	JOG1	JOG2		
1->0	0 o. 1	0 o. 1	0 o. 1	0 o. 1	=>	decelerate to zero with emergency stop ramp (see Function 1)
1	**1 ->0**	**0**	0	0	=>	decelerate to zero with ramp (see Function 2)
1	**1**	**0**	0 o. 1	0 o. 1	=>	velocity control with external reference (see Function 3)
1	**0**	**0**	**1**	0	=>	velocity control with internal reference REF1 (see Function 4)
1	**0**	**0**	0	**1**	=>	velocity control with internal reference REF2 (see Function 4)
1	1	**1**	0 o. 1	0 o. 1	=>	Indirect tension control (see Function 5)

Commands:	EME_STOP	:	Emergency stop NOT (1 at Terminal X6:5)
	DRIVE_RUN	:	Drive enable
	WIN_ON	:	Winder function (indirect tension control)
	JOG1	:	Jogging mode with reference REF1
	JOG2	:	Jogging mode with reference REF2

Table 1 Commands for the operating mode and for reference selection

Explanations for:

Function 1 The signal 0 for EME_STOP (=> EMERGENCY STOP) causes the reference to be set to zero. Even when the WIN_ON command is being received, the winder excitation is not longer active.

Function 2 When the RUN signal changes from 1 to 0, the drive will be run to zero along the ramp, when EME_STOP is still 1.

Function 3 If the WIN_ON command has not been given, the velocity control is active. The externally specified reference is passed over the run-up ramp. The desired velocity can be maintained only if the.

Function 4 The JOG1 and JOG2 commands give you an option for inching mode. The references are passed over the run-up ramp. Here. too, the desired velocity can be maintained only if the internal diameter also corresponds to that of the coil.

Function 5 The WIN_ON command activates winder operation with indirect tension control. The reference taken for precontrol of the velocity controller is (for the unwinder) the value of the WIRAD parameter, and (for the rewinder only) the velocity reference too. The controller's output is limited by the function of the tension control. The actual velocity is influenced by the material being moved, and by the calculated diameter. If the material web breaks, for example, the calculations may be incorrect, resulting in high motor speeds due to the lack of correlation between the velocity reference and the motor speed.

2.2 Velocity feedback

Parameter : P. 4/12

	FB :	AITAC	Analog input of tachogenerator
101	P1	AITAC CONV MODE	Scaling of tachogenerator input
102	P2	AITAC HIGH VALUE	
103	P3	AITAC LOW VALUE	
	FB :	SPEED MEASUREMENT	Conditioning and selection of the speed feedback
2103	P1	SPEED SCALING	Incremental encoder matching
2101	P2	TACHOPULS NR	
2102	P3	SPEED MEAS MODE	Speed feedback selection
2104	P4	SPEED ACT FTR	Filter time constant 1
2105	**! ! !**		is overwritten by FILTER (3704)
	FB :	PARW_504	Parameter
3704		FILTER	Diameter-dependent smoothing (overwrites 2105 of SPEED MEASUREMENT)

For calculating the velocity feedback, the motor speed and the diameter are required.

The motor speed can be determined both with an incremental encoder and with an analog tachogenerator.

Incremental encoder:

The line number of the existing incremental encoder is entered with Parameter 2101 (P2), the maximum necessary sped with Parameters 2103 (P1). The feedback is switched through when Parameter 2102 (P3) has been set to the value of 3 (also possible where appropriate: 0 .. 2).

Tachogenerator :

With Parameter 101 = 1 (P1 AITAC), the input is switched through as a voltage value. Weighting with Parameters 102 and 103 must be greater than 100 %, so that an overshoot can be detected.

The speed feedback is smoothed with Parameter 3704 (FILTER) in dependence on the diameter. The preset value corresponds to the smoothing at minimum diameter.
When calibrating the maximum speed, care must be taken to ensure that at maximum reference and minimum diameter (empty core) the maximum necessary rated motor speed is set.

E.g. : Given a max. reference presetting, without advance, of 100 %, and with presetting of the smallest diameter (empty core), the motor speed must be set so as to ensure that the circumferential velocity of the empty core corresponds to the velocity specified. Of course, the maximum rated motor speed must not be exceeded here.

2.3 Velocity controller

Parameter : P. 7/12

	FB :	SPEED CONTROL	Velocity controller
2014	! !	KP	is overwritten
2018	! !	KI	is overwritten
	FB :	PAR_414 ... _418	Parameter
3288	P1		Amplification increase with expanding diameter
3289	P1	KP	Amplification with velocity control
3290	P1	KP	Amplification with tension control
3291	P1	KI	Correction time with velocity control
3292	P1	KI	Correction time with tension control

The velocity reference selected and the actual value calculated from the motor speed and the diameter are the input signals for the SPEED ERROR building block. The difference is the input for the velocity controller (here SPEED CONTROL).

For the **velocity control** (WIN_ON = 0 or EME_STOP = 0), the following applies:

Amplification is composed of a fundamental component, Parameter 3289, and a diameter-dependent increase, Parameter 3288. If no increase is desired, the value of this parameter must be set to zero.
The factor of 1 for amplification increase signifies that at maximum diameter the amplification of the fundamental value multiplied by the ratio of diameters is obtained.

The correction time is set with Parameter 3291, and should be optimized for the maximum diameter.

For the **tension control** (WIN_ON = 1), the following applies:

The amplification is composed of a fundamental component, Parameter 3290 and a diameter-dependent increase 3288.
The correction time is set with Parameter 3292, and should be optimized for the maximum diameter.

Amplifications:

The value 100 of Parameter 3289 or 3290 signifies an amplification of 1 at the minimum diameter. This amplification can be increased by the following factor for the maximum diameter:

$$\text{Factor} = \frac{[\text{value from 3288}]}{1000} * \left(\frac{\text{CALCDIA}}{\text{DIAREL}} - 1 \right) + 1$$

3. Diameter

Parameter : P. 6/12

	FB :	DIAREL	Parameter
3701		DIAREL	Diameter ratio
3702		DIA_S	Internal value, which can be set with the DIASET command
	FB :	DIAMETER CALCULATOR	Diameter calculator
3808	P1	LIMWR	Limitation for incorrect calculation direction
3809	P2	LIMRI	Limitation for correct calculation direction
3810	P3	TN	Time constant
3811	P4	TDEDIA	Selection: with diameter-dependent time constant
3812	P5	LEVSP	Speed feedback stop threshold
3807	P6	LEVVEL	Velocity stop threshold

Scaling:

The internal value for the maximum diameter is 100 % = 4000

3.1 Diameter ratio

The ratio between the minimum (smallest core) and maximum diameter on this line must be calculated, and entered as a value in Parameter 3701.

$$[3701] = \frac{\text{minimum diameter}}{\text{maximum diameter}} * 4000$$

The lower limit for this parameter has been defined as 100, and the upper limit as 4000.

Even if an external specification is involved, the internal diameter value cannot then become either smaller or larger. This entry is required before speed calibration at the latest.

3.2 Diameter specification

Parameter 3702 is provided for entering the diameter, e.g. as initial diameter. The diameter is set to this value when the DIASET command (Set Diameter) is given at X1:1 (Expansion of SDCS-IOE-1).

Entering the diameter is necessary in order to start the winding function with the correct value.

$$[3702] = \frac{\text{ongoing diameter}}{\text{maximum diameter}} * 4000$$

If an external diameter specification is desired, this can be done by rerouting input 3803 to the analog input.

3.3 Diameter computation

The diameter is computed from the absolute value of the weighted velocity, the absolute value of the speed feedback, and the diameter ratio DIAREL (3701). To avoid abrupt jumps, the calculated diameter signal is passed through an integrator. The time constant is set with Parameter 3810 (P3: TN). Parameter 3811 (P4: TDEDIA) can be used to select whether this time constant is to be weighted in dependence on the diameter (expedient when a sizeable diameter ratio is involved).

The difference signal (reference/actual diameter) is additionally limited with two values, in dependence on direction. The value of Parameters 3808 (P1: LIMWR), ensures limitation of the incorrect calculation direction, irrespective of whether rewinder or unwinder is involved. The correct calculation direction is limited by means of Parameter 3809 (P2: LIMRI).

Example: At the rewinder, the increase (diameter increasing) is limited, while at the unwinder the decrease (diameter decreasing) is limited.

3.4 Halting calculation

When the diameter calculator is halted, the ongoing value is frozen, and can be overwritten only by means of the "Set diameter" command (DIASET) or by switching off the electronics.

Every single one of the following functions is sufficient to halt the diameter calculator:

- EMERGENCY STOP command (EME_STOP = 0)
- Controller block (external and internal)
- Motor speed smaller than the threshold preset with Parameter 3812 (P5: LEVSP)
- Velocity reference smaller than the threshold preset with Parameter 3807 (P6: LEVVEL)
- WIN_ON command not present

The thresholds for the speed and the velocity must be set so as to ensure that the diameter calculator can still just work to the production values involved. If the thresholds are too small, the calculated diameters will be very imprecise, due to the low values involved.

4. Indirect tension control

Parameter : P. 4/12, 8/12

	FB :	AI3	Analog Input X3:7
110	P1	AI3 CONV MODE	Scaling of the velocity reference
111	P2	AI3 HIGH VALUE	
112	P3	AI3 LOW VALUE	
	FB :	TENSION REFERENCE	Tension reference
3858	P1	TRED_IN	Internal value for the tension reduction
3857	P2	DIARED	Diameter value for the reduction start
3855	P3	MINREF	Minimum tension reference
3856	P4	INREF	Internal tension reference
3859	P5	T	Time constant for reference ramp
	FB :	TORQUE FR. TENSION	Tension torque
3864	P1	WEIGHT	Tension current weighting

The WIN_ON command (winder excitation ON) at X1:4 enables the **indirect tension control**.

4.1 Reference and reduction

The tension reference is specified at Terminal X3:7. Parameter 110 =1 is used to activate the voltage range from 0 to ± 10 V. This tension reference is then passed through an absolute value generator.

The tension is not reduced against growing diameter if Parameter 3858 (P1: TRED_IN) possesses the value of 0. If this value is greater than zero, then the tension will be reduced as from the diameter set with Parameter 3857 (P2: DIARED), by the value of Parameters 3858 (P1: TRED_IN). The following formula applies for this case:

$$\text{Conditioned tension reference} = \text{Tref} * \left(1 - \frac{\text{Tred}}{20000} \right)$$

where

Tref : tension reference(10V = 20000)
Tred : reduction reference (TRED_IN : 0 ... 20000)

Tension reduction is also possible with an external analog value, if a still-free analog input is assigned the block input 3850 (TRED_EX) and block input 3854 (FOLEXT) is assigned the signal -1.

Instead of the above-specified tension reference, an internal value, Parameter 3856 (P4: INREF), can also be set using the TENREF_INT command at Terminal X1:2 (expansion to SDCS-IOE-1).

4.2 Ramp and limitation

The conditioned tension reference is limited to a minimum value by means of Parameter 3855 (P3: MINREF). This limit value cannot be violated downwards by the external reference and not by the reduction function either. The internal value TENREF_INT is independent of this.

The tension reference selected is finally passed over a ramp, whose integration time can be set using Parameter 3859 (P5: T).

If the command for indirect tension control (WIN_ON) is not present, the output for the ramp function Is set to zero.

4.3 Matching the tension current

To convert the tension reference into the requisite torque, the ongoing diameter plus a weighting factor, Parameter 3864 (P1: WEIGHT), are used. This parameter can be set in per mil, and represents the ratio between the requisite torque (corresponds to the armature current without field weakening) and the maximum unit current. The maximum unit current is the rated unit current when the current burden has not been altered.

$$[3864] = \frac{\text{maximum tension current}}{\text{maximum unit current}} * 1000$$

This result is used to limit the overridden velocity controller.

5. Losses and acceleration

Parameter : P. 9/12

Loses

	FB :	FUNG-1V	Curve generator y=f(x)
3230	P1	X1	1. X-coordinate, speed (=0)
3231	P2	Y1	1. Y-coordinate, leakage current
3232	P3	X2	2. X-coordinate, speed
3233	P4	Y2	2. Y-coordinate, leakage current
3234	P5	X3	3. X-coordinate, speed
3235	P6	Y3	3. Y- coordinate, leakage current
3236	P7	X4	4. X-coordinate, speed
3237	P8	Y4	4. Y-coordinate, leakage current
3238	P9	X5	5. X-coordinate, speed (=20000)
3239	P10	Y5	5. Y-coordinate, leakage current
	FB :	LOSS WEIGHTING	Loss weighting
3821	P1	MUL1	Factor 1 for diameter-dep. losses
3922	P2	MUL2	Factor 2 for diameter-dep. losses; active only with Signal SET_M2 := -1.

Acc.

	FB :	FILT-1	Smoothing
3193	P1	T1	Time constant
	FB :	DT	Differentiator
3903	P1	Tn/Tz	Time constant
3902	P2	K	Matching

	FB :	ACCELERAT. TORQUE	Acceleration torque
3843	P1	SWLEV	Threshold for the INLEV message, and simultaneously sign changeover
3844	P2	WEI-MP	Weighting of the positive component for the winder mechanism
3845	P3	WEI-MN	Weighting of the negative component for the winder mechanism
3846	P4	WEI-RP	Weighting of positive component for the material already wound
3847	P5	WEI-RN	Weighting of negative component for the material already wound
3848	P6	WEWI	Material width

The desired tension can only be maintained if the losses and the acceleration values are also known and have been entered. The total is incorporated directly in the control as an additional torque.

Important note:

If the value entered is far too high, it may happen that the velocity controller can no longer intervene to correct it, i.e. the drive may ramp up when it is not supposed to.
This torque increment is thus automatically blocked when an error message occurs, when the tension control operation mode has not been selected, or when the EMERGENCY STOP command has been given.

5.1 Loss weighting

The losses at the winder mechanism must be determined with an empty core and with the winder itself at operating temperature.

Proposal:

In the velocity control mode, beginning with the reference 0, determine the current in corrected condition, and enter the values for speed (X) and current (Y) in a diagram. For this purpose, the ramp function generator should be run with a long ramp, with low amplification, and a long correction time. In practice, you will find it best to record the values not in physical, but in internal variables (option provided in the CMT tool). The first point is at a speed of 0, and the last at 20000. From the values recorded, (e.g. 20 coordinates), determine 5 corner points, beginning at the sped of 0 (=> turn-on) and ending at a speed of 20000. These corner points must then be transferred into the curve generator.
After the run, please write the previous values into the ramp function generator and into the velocity controller.

If diameter-dependent losses are determined, this value can be entered with Parameter 3821 (P1: MUL1). The value corresponds to the unit current at the greatest diameter.

5.2 Acceleration weighting

The acceleration (dv/dt) is determined from the velocity reference. Small pollutions are smoothed out with the filter before the differentiation routine is executed. The difference signal is amplified with Parameter 3902 (P2: K), and can then be smoothed with the time constant Tn/Tz, 3903 (P1). The setting must be chosen so as to ensure that the output signal does not exceed the value of 20000.

Parameter 3842 (P1: SWLEV, ACCELERATION TORQUE building block) is used to specify the threshold defining the output value as from which the acceleration torque is to be switched through.

Torque weighting for the mechanical component, i.e. winder including empty core, is set for the acceleration with Parameter 3844 (P2: WEI-MP) and for the deceleration with Parameter 3845 (P3: WEI-MN).

Torque weighing for the material being wound, i.e. winder plus full material coil, is set for acceleration with Parameter 3846 (P2: WEI-RP) and for deceleration with Parameter 3847 (P3: WEI-RN).

The parameters for the weighting function can be determined by run-up and run-down trials. First of all, run the winder with an empty core in the tension control function, but with a tension weighting of 0, and with an external reference ramp. Observe how the reference and the feedback behave (e.g. CMT tool or oscilloscopes). Parameters 3844 and 3845 must be set so as to ensure that the feedback approximately follows the reference. Then determine Parameters 3846 and 3847, using the same procedure, but with a full coil of material.

6. Torque and current limitation

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The torque reference is supplied by the velocity controller. The limitation function is provided by the TORQUE / CURRENT LIMITATION building block.

In the tension control operating mode, the limitation obtained from weighting of the tension torque also applies. The sum of the losses and acceleration torques is added.

All other functions valid in this context conform to the basic software.

7. Current control

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The current controller conforms to the basic software.

8. Field supply

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The field supply conforms to the basic software.

9. Messages

P. 12/12

Internal values and monitoring functions differ partly in blocking and partly in annunciatory results. Error messages can be reset by switching off the electronics or using the RESET command.

All other messages conform to the basic software.

9.1 Winder-specific messages

Parameter : P. 12/12

	FB :	PARW_510	Parameter
3711		DIA_LEV	Annunciation threshold for diameter
	FB :	WINDER LOGIC	Winder messages
3867	P1	T-ON	Time for signal duration

If the preset threshold for Parameters 3711 is violated upwards at the rewinder or downwards at the unwinder, the binary signal 13819 (OUT) will be received at Terminal X7:7 for the time value from Parameter 3867 (P1: T-ON).